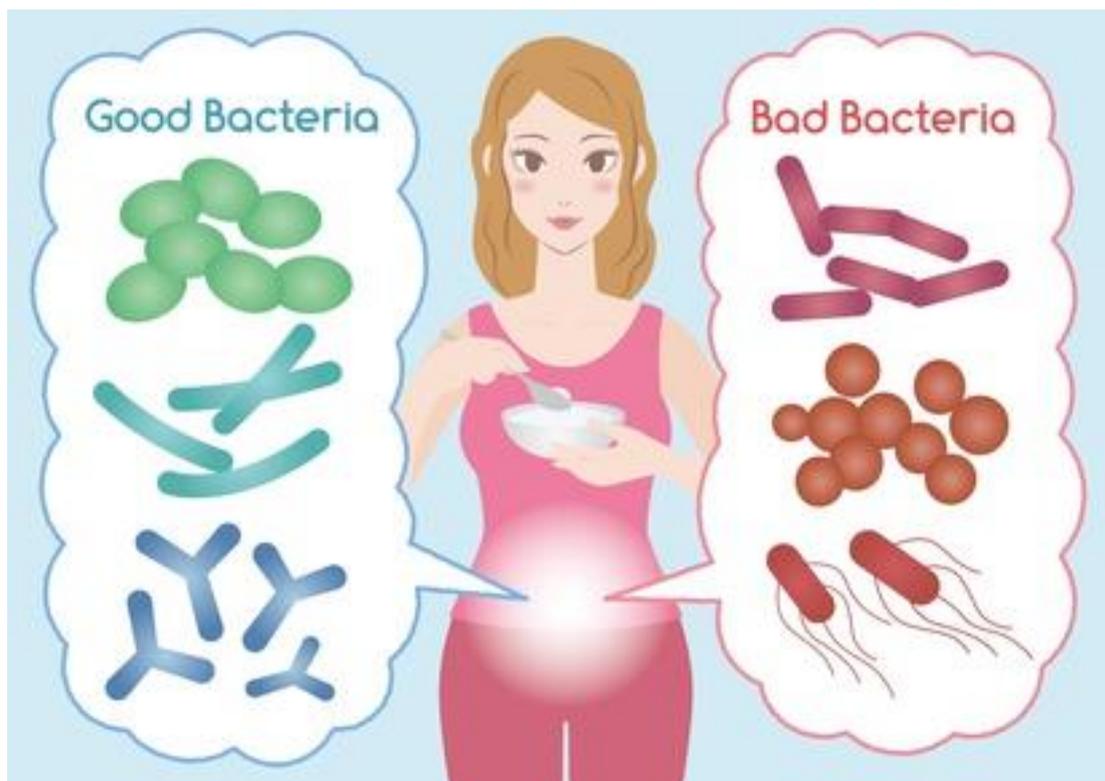


HOW PROBIOTICS IMPROVE YOUR HEALTH



THE MANY WAYS THAT 'FRIENDLY BACTERIA'
AND LIVE CULTURES BENEFIT YOU

By

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E-PUBLISHED MAY 2017

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How probiotics can boost your health

PRO = FOR
BIOTIC = LIFE

The discovery of how a strain of bacteria survived for 25 million years in a state of suspended animation is one reason health scientists' view of probiotics has changed.

Until recently most probiotics in supplements or yoghurts were thought to be more smart marketing than good science. That's now changing.

Health researchers were always agreed that probiotics – the microscopic 'good' bacteria in your gut – are vital for your health. But there were doubts whether taking probiotics in supplements was effective and severe doubts that probiotics in yoghurts survived being eaten.

What's known is that probiotics:

- Are critical for your immune system
- Are vital for your digestion
- Fight food-borne illness
- Crowd out pathogenic (dangerous) bacteria, yeasts and fungi
- Synthesise certain vital vitamins like B12, folic acid and K2

... and now we are discovering that they are also able to:

- Fight inflammatory diseases like IBS and colitis
- Reduce the risk and duration of urinary tract and candida infections
- Help prevent traveller's diarrhoea
- Affect mood and reduce stress
- Aid weight loss

... and may have a role to play in cutting the risk of some cancers, Parkinson's and even Alzheimer's .

But, as we've already said, until recently many health researchers were doubtful that taking probiotics in yoghurt or supplement form works. And regulators have been slow to approve health claims for probiotics.

Set against these doubts, Harvard Medical School, in a summary on probiotics in 2015, stated:

“A growing body of scientific evidence suggests that you can treat and even prevent some illnesses with foods and supplements containing certain kinds of live bacteria.

“Some digestive disease specialists are recommending them for disorders that frustrate conventional medicine, such as irritable bowel syndrome. Since the mid-1990s, clinical studies suggest that probiotic therapy can help treat several gastrointestinal ills, delay the development of allergies in children, and treat and prevent vaginal and urinary infections in women.”

Other respected research institutions strongly recommend probiotics after a course of antibiotics. So why the controversy?

It's because for probiotics to positively affect your health they need to:

- ✓ Be live when you consume them
- ✓ Be present in sufficient numbers
- ✓ Survive being eaten
- ✓ Pass, still alive, through the stomach, which is highly acidic.

They then need to establish themselves in the lower gut where they must remain and breed, in order to boost the numbers and range of the existing 'friendly' colonies there – and to 'crowd out' and decrease the number of disease-producing bacteria. Because the wider the range of beneficial probiotics in your gut, generally the healthier you are.

Probiotics that work

The aim of this report is to give you the latest research, what is fact, and what is unproven, the best probiotic (and prebiotic) foods to eat and the benefits of a new generation of probiotic supplements called endospore probiotics.

Endospore probiotics are changing experts' minds about the viability of probiotic supplements. Endospore bacteria are a family of bacteria that has evolved over time to develop a shell that protects them against extremes of heat, cold, moisture, dehydration, enzymatic destruction and even UV radiation.

How hardy are these endospore bacteria? Well, scientists examining the stomach content of a fossilised bee that had been trapped inside amber for 25 million years, found it contained viable *Bacillus* bacterial endospores. In fact 'endo-' means 'inside' and '-spore' refers to a 'dormant structure.'



Nebraska University has specialised in probiotic research for over 85 years. Scientists there have now developed probiotic bacteria with the same shell mechanism that preserved the bacillus endospore bacteria in suspended animation within that bee.

These strains are able to survive the harsh acids of the bile duct and stomach and the anaerobic (no oxygen) environment of your intestines. Once endospore bacteria reach the small intestine, the shell disintegrates – so the bacteria remain in the gut and can reproduce to form a colony.

There are now other strains, too, that definitely do survive to increase the numbers and variety of ‘friendly bacteria’ strains in your intestines. They include **Lactobacillus Acidophilus DDS-1** – also developed at Nebraska University.

The key probiotic questions

This report will answer these key questions:

- ✓ Which probiotics actually survive to reach the gut? They don't all!
- ✓ What numbers of probiotic bacteria do you need in a supplement to be effective?
- ✓ Which strains are most effective and how many strains should a supplement include?
- ✓ Are yoghurts an effective way to boost your probiotic status?
- ✓ When do you need to specifically boost the level and range of the probiotics in your gut? Because few people need to take a probiotic supplement continuously.

For those who want the findings immediately, here is a summary of the top 10 reasons to take a probiotic supplement.

But please do read the whole report – you will find some fascinating facts about your body we guarantee you didn't know!

There is an extensive reference list at the end (pp. 34-35).

THE TOP TEN REASONS FOR TAKING PROBIOTIC SUPPLEMENTS

1. Probiotic strains have now been developed that do reach the gut and can colonise there. These include resistant strains like the endospore ***Bacillus coagulans ProDURA™*** and ***Lactobacillus acidophilus DDS-1***.
2. Increased diversity of probiotic bacteria is linked to reduced risk of many diseases. So a supplement with at least 5 strains of probiotic is better than high levels of one or two strains.

The make-up of each person's intestinal flora is unique. So a probiotic supplement with only one or two strains in it may have noticeable benefits for one person but not the next. Whereas a multi-strain probiotic supplement has a far better chance of delivering its health benefits.
3. Increasing the number and variety of probiotics in your diet is very important after a course of antibiotics – because antibiotics kill off both good and bad bacteria.
4. Boosting probiotic levels can fight candida yeast infections, prevent traveller's diarrhoea, reduce stress levels and possibly support weight loss.
5. Increasing the level and diversity of 'friendly' bacteria supports the health of your immune system, as 70% of this is located in the gut. Certain probiotic strains may also have an anti-cancer role.
6. The balance of bacteria in the gut directly affects mood and can even reduce the risk of some neurodegenerative disease.
7. A deficiency of probiotics in older people is now thought to contribute to memory loss and impaired cognition.
8. Probiotics, by synthesising vitamin K and by helping the absorption of calcium, help reduce the risk of osteoporosis.
9. Yoghurts have health benefits, but are not usually an effective way to boost your probiotic balance. High temperature pasteurisation kills both good and bad bacteria, and independent studies show that few good bacteria from yoghurts actually reach the gut.
10. Probiotic bacteria are living organisms and need their own food to thrive. These foods are called prebiotics. So any well designed supplement will not only include resistant probiotic strains but some prebiotics as well.

PROBIOTICS AND THE MICROBIOME

The microbiome one of the hottest topics in health research now!

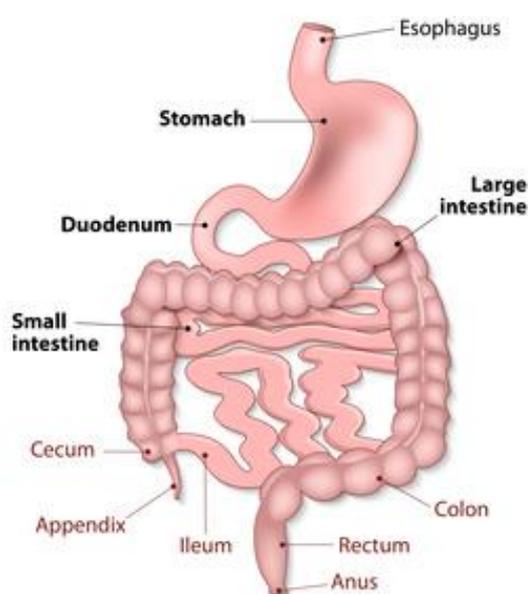
The term **microbiome** was coined by the Nobel laureate Joshua Lederberg. Strictly speaking, it refers to the combined genetic material of all the microbes that we are host to, whereas the actual trillions of microbes themselves are called your **microbiota**. But we will use the word microbiome because that is the term used by the Human Microbiome Project completed in 2011.

Your microbiome is unique

Like your DNA, your microbiome is unique to you and made up of bacteria on your skin, in your mouth and crucially in your digestive system.

The digestive system or gut

HUMAN GASTROINTESTINAL TRACT



Your digestive system (also referred to as the “gut”) comprises the:

STOMACH

- breaks down and digests food

SMALL INTESTINE

- about 20 feet long, where most nutrients are absorbed

COLON/LARGE INTESTINE

- removes water from digested food and creates stools

Two astonishing facts

70% OF YOUR IMMUNE SYSTEM IS LOCATED IN YOUR GUT

Trillions of tiny benevolent 'good' bacteria live in our intestines and they metabolise the food that the stomach will have partially digested, extracting the nutrients we need.

Weighing a total of about 2kg, they help to defend us against and 'crowd out' bad (pathogenic) bacteria which can produce toxins that are absorbed into the bloodstream and cause disease. Good health depends on the right balance between 'good' and 'bad' bacteria.

So your gut health determines your immune system health. And your immune system health determines how well you resist not just colds and flu, but long developing diseases like cancer.

YOU HAVE A 'SECOND BRAIN' IN YOUR INTESTINES

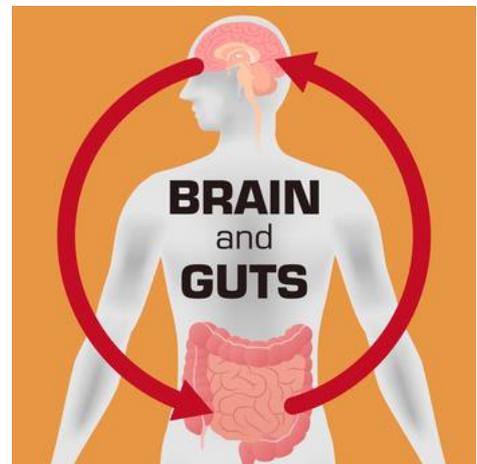
The **enteric nervous system** has been dubbed 'your second brain' by researchers. It comprises about 500 million neurons (nerve cells) lining the long tube of the gastrointestinal system.

Originally the enteric nervous system was thought to only direct the process of digestion. It does that, but we now know that it also produces hormones and chemically communicates directly to the brain – conveying emotions and affecting mood.

So **'butterflies in the stomach'** are part of our stress response originating in the second brain.

A **'gut feel'** that we don't trust someone is literally our brain below communicating to our brain above.

And we've all eaten something that **'didn't agree with us'** – and later our gut brain 'knew' to avoid that same food again.



Vital for mood balance

The enteric nervous system (ENS) uses over 35 neurotransmitters in a similar way to the brain and an extraordinary **95%** of the body's **serotonin** is found in the gut.

Serotonin is the 'feel-good' neurotransmitter responsible for maintaining a stable mood balance – a sense of wellbeing. Researchers are finding that an alteration in the balance between 'good' and 'bad' intestinal bacteria can directly alter mood, anxiety and even confidence.

Irritable Bowel Syndrome (IBS) is now thought to be caused – at least in part – by a gut infection or stress in a child's early years. This affected the normal production of serotonin and therefore the normal development of the neurons in the ENS. Recent research showed that some 87% of people with IBS had antibodies in their circulation that were attacking neurons in the gut.

The new science of neuro-gastroenterology

So important is this communication from the gut to the brain that a new science of neuro-gastroenterology is emerging.

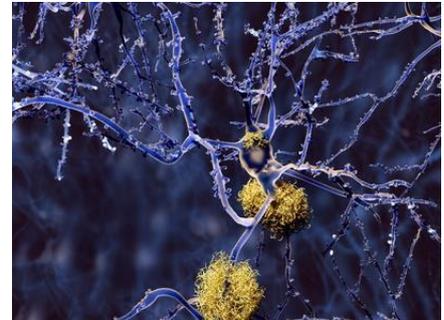
Scientists in the field confirm that our mental health is influenced by the health of our gut. Michael Gershon at Columbia-Presbyterian Medical Center, New York states that:

“A lot of the information that the gut sends to the brain affects well-being, and doesn't even rise to consciousness.”

Pankaj Pasricha, Director of the Johns Hopkins Center for Neuro-gastroenterology in Baltimore, believes that a fuller understanding of the role of the 'second brain' can help us control all sorts of conditions, from obesity and diabetes to mental issues like depression, and even Alzheimer's and Parkinson's.

Mental health and gut health

Research has shown that depression is frequently associated with gastrointestinal inflammation – a common symptom of food intolerance. And significantly the characteristic plaques or tangles found in the brains of people with Alzheimer's are present in neurons in their guts, too.



ALZHEIMER'S PLAQUE TANGLES

Recent studies have demonstrated that a healthy microbiome has a direct role in mental health, with people who regularly consume probiotics having less anxiety and depression. When their saliva was tested it contained lower levels of cortisol – the stress hormone – than control patients.

Lower levels of anxiety may also be because the amino-acid tryptophan is created during fermentation triggered by probiotics. And tryptophan synthesises serotonin which alleviates anxiety.

PROBIOTICS → FERMENTATION → TRYPTOPHAN → SEROTONIN → FEELGOOD FACTOR

If – as the researchers now say – health issues like chronic fatigue, depression, poor skin and inflammatory diseases are all affected by gut health, then a major health objective must be to increase the proportion of good bacteria in your microbiome.

Improve the balance between good and bad bacteria

Your gut contains both beneficial and harmful bacteria and these antagonists have been battling it out for billions of years! Health researchers suggest that the balance of gut flora should be approximately 85 percent good bacteria and 15 percent bad bacteria. If this ratio becomes unbalanced – a condition known as **dysbiosis** – the result is a compromised immune system and ill health.

Dysbiosis can have especially detrimental effects on older people. Overgrowth of unhealthy bacteria in the small intestines is called **Small Intestinal Bacterial Overgrowth (SIBO)**. This can cause '**leaky gut syndrome**' where toxins leak into the bloodstream. This powerfully stimulates inflammation throughout the body including the brain, which in turn can lead to depression, anxiety and impaired memory.

Now we know that the gut-brain axis is so influential, scientists are speculating that a deficiency of probiotics in older people can contribute to memory loss and disorientation.

By consuming the right probiotic food and supplements you can help bring the ratios of healthy bacteria back into balance. To over-simplify – more 'good' bacteria leave less room for the 'bad' ones.

Data from the Human Microbiome Project shows that the average microbiome of someone living in a western industrialised country has fewer beneficial probiotic bacteria, and crucially less variety of probiotics, than those in rural and non-industrialised countries. It also shows that a wider range of probiotics is strongly linked to better health.

Probiotics are critical to health – indeed the derivation is **pro** (for) and **biotic** (life). But probiotics on their own are not enough. Probiotics are living beneficial bacteria and like any living thing, they need their own food supply. This 'food' is called **prebiotics**.

Probiotics need prebiotics

Prebiotics are non-digestible plant fibres that bacteria break down and feed on. The two most common subtypes of prebiotics are the closely related **inulin** and **fructo-oligosaccharides** or **FOS**. A third subtype **galacto-oligosaccharides** or **GOS** are synthesised from lactose in milk by enzymatic activity within the body. GOS are also present in several nondairy foods such as grains, legumes and cruciferous vegetables.



Every culture has had to rely on fermentation to preserve foods in the non-growing seasons. Germans developed **sauerkraut**, Bulgarians **kefir** and **yoghurt**, Asian cultures created **tempeh**, **kimchi**, **natto** and **miso**, and Russians '**raw**' yoghurt.

These all contain many strains of probiotics and many of them are naturally based on foods that contain a lot of prebiotics, too. For instance, sauerkraut is based on cabbage, which contains GOS.



See [Appendix B](#) (p.32) for more details about the top probiotic foods.

What disturbs the microbial balance?

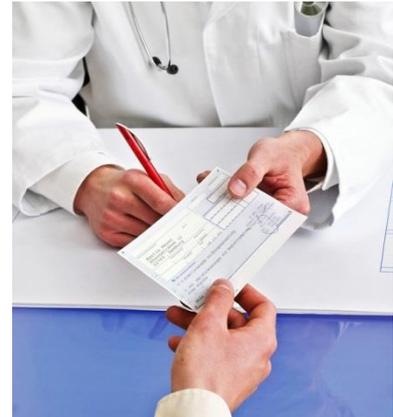
ANTIBIOTIC TREATMENTS

One of the main culprits for the reduction in beneficial probiotics is antibiotics. Although the development of antibiotics is amongst the greatest medical advance of the 20th century, they have a flaw. Antibiotics may well kill a pathogenic bacterium, but they also attack good bacteria along the way – internal ‘friendly fire’.

The reduction in number and range of protective probiotic bacteria that inevitably follows a course of antibiotics is why antibiotics can cause nausea and upset stomachs – and encourage candida yeast infections. The imbalance can last up to a year or more.

By killing good as well as ‘bad’ bacteria, antibiotics can cause gastrointestinal inflammation and vulnerability to pathogens like *C. difficile*. Salmonella can cause infection at a dose 1,000 times lower if the patient is on antibiotics!

This is why you should only take an antibiotic when really necessary and always complete the dose. If you do not complete the course it is quite possible that some of the original pathogens will be left and they can and will develop resistance. It's one reason we have an antibiotic crisis, and why we are seeing a massive evolutionary change in bacteria – the rise of the super-bugs that make a visit to a hospital a risky trip.



RESIDUAL ANTIBIOTICS IN MEAT AND MILK



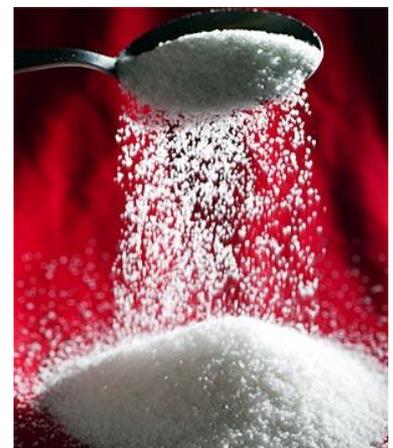
Unfortunately it's not only the course of antibiotics prescribed by a doctor that causes the problem. We also ingest antibiotics indirectly as they can be residual in non-organic meats and milk. Indeed the over-use of antibiotics in animals is far greater than that in humans.

STRESS, PESTICIDES AND SUGAR

A decrease in healthy bacteria can also be caused by **stress** and elevated cortisol.

Antacids and acid lowering drugs also negatively alter the bacterial balance and can increase the level of disease, encouraging bacteria like *C. difficile*, which can cause severe illness.

Other causes of dysbiosis include some **artificial sweeteners**, **pesticide** residue and importantly too much **sugar**. Sugar promotes unhealthy bacteria and yeasts in the gut.



PROBIOTIC BENEFITS

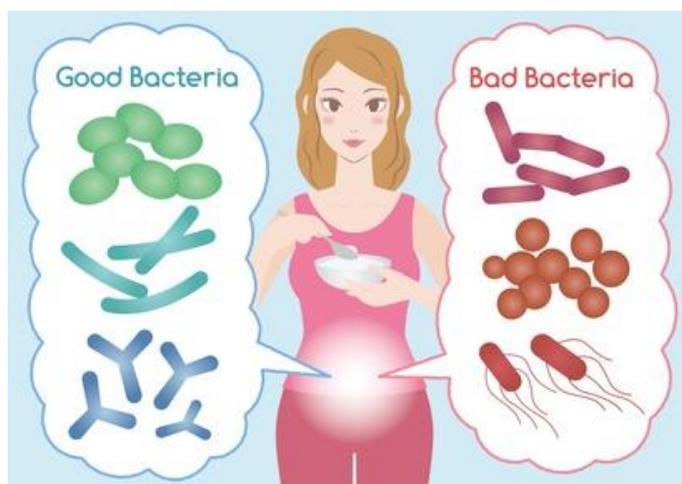
IMPROVED IMMUNE FUNCTION

Regular probiotic supplementation has been shown to maintain intestinal health and enhance natural immune system response by stimulating the body's production of Natural Killer and T-cells.

BETTER DIGESTION

By helping to increase the number of healthy bacteria in the gut, probiotics improve digestion and can reduce bloating, gas, constipation and diarrhoea. But how?

Some strains like ***Lactobacillus acidophilus*** create lactic acid, which then reduces the pH (alkaline level) of the intestine. This speeds up the digestive process and allows stools to pass through the colon more quickly, which in turn reduces the incidence of constipation.



STOP DIARRHOEA

When the digestive system is overrun by harmful bacteria, the gut cannot absorb all the food – and the result is diarrhoea. Probiotics are therefore a natural alternative to over-the-counter remedies that can have unwanted side effects.

IMPROVED NUTRIENT ABSORPTION

There is evidence that as we age the body becomes less efficient in digesting food and extracting nutrients from it. A healthy level of probiotics can aid nutrient absorption by improving digestion. They do this by producing more of the enzymes that break down food.

LOWERED CHOLESTEROL

Probiotics aid the digestion of fats and some strains like ***Bacillus coagulans*** have been shown to help lower LDL (the 'bad' form of cholesterol) and increase HDL levels (the good form).

MORE ENERGY?

Since better digestion improves metabolism, the result might translate to better energy levels. However, the research on probiotics and improved energy show mixed results. In some cases supplementation with probiotics does improve energy and in others it does not. Researchers believe that this is due to the significant difference in microbiome make-up between individuals.

The conclusion from this – and indeed the research generally – is that a probiotic supplement with multiple strains is likely to be more effective, because this increases the probability that it will include the strains that most benefit you.



NATURAL ANTIBIOTICS

We've seen that pharmaceutical antibiotics can negatively disturb probiotic balance. But some strains of probiotic (like ***Lactobacillus bulgaricus***) can act as natural antibiotics.

In documented research, the strain ***Lactobacillus acidophilus DDS-1*** has been shown to produce the natural antibiotic-like substance **acidophilin**, which kills pathogenic bacteria like salmonella and *E. coli*.

Dr Khem Shahani, from the *University of Nebraska* and the developer of ***L. acidophilus DDS-1***, has demonstrated that it has a similar antibiotic effect to streptomycin (a strong antibiotic), but that the effect was selective – killing just the pathogenic bacteria.

COMBATING CANDIDA YEAST INFECTIONS



Candida albicans is the most common type of yeast infection found in the mouth, intestinal tract and vagina.

Candida yeast in normal amounts helps with digestion and the absorption of nutrients. But when candida overproduces, symptoms may appear that include chronic fatigue, hormonal imbalances, mood disorders and thrush, which itself causes itching and discomfort.

Left unchecked, candida overgrowth breaks down the walls of the intestinal lining and penetrates into the bloodstream. This releases by-product toxins and other toxins from your system, causing leaky gut syndrome and can even infect membranes around the heart or brain.

Researchers have identified sugar-rich Western diets, together with excessive use of antibiotics, as a reason for the big increase in candida

yeast infections. *Candida* thrives on food sugars and vaginal candidiasis often follows antibiotic therapy. Other contributing factors include birth control pills and cortisone drugs.

Probiotics – and especially ***Lactobacillus acidophilus*** and ***Bifidobacterium bifidum*** – can stimulate the production of white blood cells in the body that combat candida yeast and fungal infections. A 1990 report in the *Lancet* recorded that women with candida were cleared of the condition with a course of ***L. acidophilus***.

RESISTING CANCER?

Both ***Lactobacillus bulgaricus*** and ***L. acidophilus* DDS-1** (note that **L.** here – and usually elsewhere – is shorthand for lactobacillus) have been shown in laboratory studies to inhibit tumour growth and help block the formation of carcinogenic compounds. The collaborative research was conducted by Nebraska's Dr Shahani and the *Sloan Kettering Institute* in New York. Anti-tumour effects have also been detected in ***L. casei*** and ***Streptococcus thermophilus***.

The mechanism for this potential effect is not totally clear but was investigated in a 2008 paper by M T Liong on pro- and pre-biotics and colon cancer in the *International Journal of Molecular Sciences*.

“Probiotics ... In-vivo and molecular studies have demonstrated encouraging outcomes, mainly attributed to its antimicrobial effects against carcinogen-producing microorganisms, anti-mutagenic properties, and alteration of the tumor differentiation processes.

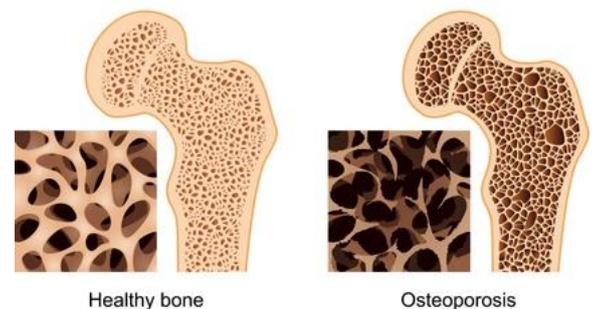
“Prebiotics ... also possess protective effect against colon carcinogenesis, mainly attributed to production of short chain fatty acids upon fermentation by gut microflora, and alteration of gene-expressions in tumor cells.

“Synbiotics ... (combination of probiotic and prebiotic) has been found to exert a synergistic effect in improving colon carcinogenesis compared to when both were used individually.”

In addition, nitrites used in food processing can be converted to carcinogenic (cancer causing) nitrosamines in the digestive tract. ***L. acidophilus*** has been shown in vitro to inhibit this chain of events.

OSTEOPOROSIS

Osteoporosis is the loss of bone density. ***L. acidophilus*** improves the ability of the body to absorb and metabolise calcium and is therefore potentially an important element in a dietary regime aimed at improving bone density. In addition ***L. acidophilus*** synthesises vitamin K, which is needed for calcium to be transported to form bone. A probiotic supplement following an antibiotic course is therefore especially important for women at risk of osteoporosis.



PARKINSON'S DISEASE

Parkinson's is the second most common neurodegenerative disease. Researchers at *Caltech University* have confirmed (December 2016) that changes in the composition of gut bacteria are contributing to – or might actually cause – the deterioration in motor skills that characterises Parkinson's disease.

The initial clue was that 75 percent of people with Parkinson's have gastrointestinal (GI) abnormalities, primarily constipation and bloating. And, says lead researcher Sarkis Mazmanian, these GI problems often precede the motor symptoms by many years.

Although the study was in mice – as inevitably so many preliminary studies are – the implications are that improving gut flora could be a way to cut the risk of this incurable disease. It is early days, however, as the researchers have yet to identify particular strains of probiotic that would form part of a preventative strategy.

Nevertheless, a preliminary conclusion is that a multi-strain probiotic is a logical defensive choice. This could be coupled with an anti-inflammatory nutritional supplement, since it's known that another characteristic of Parkinson's patients is the presence of inflammatory molecules called cytokines within the brain.

IMPROVED BLOOD SUGAR LEVELS AND REDUCED METABOLIC SYNDROME

Glucose is the blood sugar that comes, not just from refined sugar, but from metabolising carbohydrate foods. It is released into your bloodstream during digestion. Insulin from the pancreas helps break down these sugars and move them from your blood into your cells to create energy.

Research published in the *US National Institutes of Health (NIH) Library of Medicine* indicates that probiotic supplementation – specifically ***Lactobacillus*** and ***Bifidobacterium*** strains – can help maintain optimal blood glucose levels.

High blood sugar levels are part of a dangerous condition known as **metabolic syndrome**. Metabolic syndrome combines high blood sugar, high blood pressure, high cholesterol, and increased levels of adipose (body fat) tissue, especially around the tummy. This type of fat releases toxic chemicals that further increase inflammation within body tissue.

Metabolic syndrome conditions very significantly increase your risk for stroke and heart attack, as well as diabetes. The *NIH* has published studies showing that probiotic supplements can help reduce the risks for these diseases.

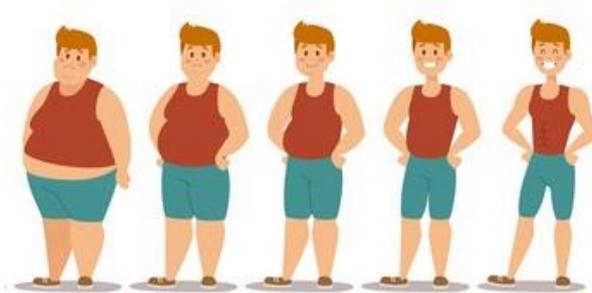


WEIGHT LOSS AND CONTROL

The *British Journal of Nutrition* noted that the intestinal flora of fatter people differs from thin ones. Could rebalancing their microbial status lead to weight loss?

To test this hypothesis, researchers recruited 125 overweight men and women. The subjects followed a 12-week weight-loss diet, followed by a further 12-week period aimed at maintaining body weight. Throughout the study, half the participants took 2 capsules daily containing probiotics from the *Lactobacillus rhamnosus* family, while the other half received a placebo.

After the 12-week diet period, researchers observed an average weight loss of 4.4 kg in women in the probiotic group and 2.6 kg in the placebo group.



After the 12-week maintenance period, the weight of the women in the placebo group remained the same, but the probiotic group continued to lose weight, up to a total of 5.2 kg.

Therefore women consuming probiotics lost twice as much weight over the 24-week period of the study. Researchers also pointed out that the appetite-regulating hormone leptin decreased as did the intestinal bacteria that characterise obesity.

The possible reason? Probiotics may act by altering the permeability of the intestinal wall. By keeping certain pro-inflammatory molecules from entering the bloodstream, the probiotics might help prevent the chain reaction that leads to glucose intolerance, type 2 diabetes and obesity.

A meta-analysis in the *International Journal of Food Sciences and Nutrition* summarised 25 randomised human trials on the impact of probiotic consumption on body weight and BMI in over 1,900 healthy adults. They found taking probiotics did reduce Body Mass Index (BMI) and body weight.

Taking more than one type of probiotic for a period of 8 weeks or more resulted in the most weight loss. Other studies have shown that subjects who supplement with probiotics can experience a measurable reduction in overall belly fat.

The potential for probiotics to contribute to achieving a healthy weight is logical, given the essential role of gut bacteria in breaking down food and nutrients.

PREVENTING TRAVELLER'S DIARRHOEA

Traveller's Diarrhoea (aka "Montezuma's Revenge") is a quite frequent and unpleasant accompaniment to the otherwise joys of foreign travel. It is an infection of the stomach and intestines that is primarily caused by unaccustomed bacteria in the foods and water consumed – the normal culprit being the enterotoxigenic *E. coli*.

Preventative strategies of course include washing your hands or carrying a hand sanitiser, using bottled water to clean your teeth, not eating salads washed in local water and not eating raw foods. But the *Journal of Nutrition* also recommends a multi-strain probiotic taken two weeks before and during the trip as a good way to cut the risk.



ORAL HEALTH

The mouth contains hundreds of species of bacteria. In addition, putrefying bacteria in the gastro-intestinal tract can cause halitosis (bad breath). One outcome of an increased level of 'good' bacteria has been found to be improved oral health and a reduction in incidence of bad breath.

REDUCED STRESS

According to the *World Health Organisation (WHO)*, stress is the fourth leading cause of disability worldwide and the 2015 *Stress in America* survey indicates worryingly increasing levels of stress in adults – to the point where 78% reported experiencing at least one symptom of stress and 24% incidents of extreme stress.

We have seen the importance and strength of the gut/brain signalling mechanism. In stressful conditions, the brain reacts and sends signals to several parts of the body, including the 'second brain' of the gut and vice versa.



There are now dozens of studies that confirm probiotics can have a role in lowering the damaging effects of stress, to the extent that one researcher has coined the term '**psychobiotics**'.

University Health News, which compiles health studies, reported on a 2015 randomised, double-blind, placebo-controlled trial (the gold standard for human trials). The trial randomly assigned patients with major depressive disorder to receive either probiotic supplements or placebo. The probiotic consisted of 2 billion CFUs each of **Lactobacillus acidophilus**, **L. casei**, and **Bifidobacterium bifidum**.

After eight weeks, patients who received the probiotic had significantly decreased total scores on the Beck Depression Inventory, a widely used test to measure the severity of depression, compared with placebo. In addition, they had significant decreases in systemic inflammation as measured by C Reactive Protein levels, significantly lower insulin levels, reduced insulin resistance, and a significant rise in glutathione, the body's key antioxidant.

In another controlled study reported in *Applied and Environmental Microbiology*, a probiotic given to medical students in the 8 weeks prior to their examinations reduced stress among the students.

Lead author Dr Kouji Miyazaki said:

*“The probiotic *Lactobacillus casei* Shirota can relieve many aspects of the stress response, especially gastrointestinal dysfunction.*

“These findings indicate that the stress responses are controlled by probiotics ... through the brain-gut axis. Thus, the probiotic strengthens the resilience of our stress response system.”

HEALTHY SKIN?

Health on the outside is a reflection of health on the inside, so many people taking a course of probiotics report better skin tone.

German researchers noted that eczema patients consistently had very low levels of lactobacilli and that a 10 week course of probiotic supplements including ***L. acidophilus*** alleviated the condition – although other studies have showed no similar benefit. Skin fungal conditions like athlete’s foot may well respond positively.

BETTER ALL-ROUND HEALTH

Recent research shows that many health problems, including colitis (inflammation of the colon), weight gain, asthma, diabetes and even depression are linked to an imbalance of probiotics.

Colitis in particular can lead to the cell walls of the intestines becoming permeable (leaky gut), increasing the chance of digestive upset and negative reactions to gluten and dairy products.

An imbalance of healthy bacteria combined with a leaky gut is now linked to an increased risk of diabetes and heart disease. And, due to the direct gut brain connection, an imbalance can also lead to neurological problems that include depression and even migraine.

One study has also suggests a link between good bacteria and seasonal allergies, particularly with hay fever.

Perhaps the best summary of benefits – albeit in medical language – is from *The Journal of Clinical Gastroenterology* 2011 titled ‘**Impact of probiotics on colonizing microbiota of the gut**’:

*“Increased levels of *Bifidobacterium* and *Lactobacillus* in the gut correlate with numerous health endpoints. Microbiota changes due to probiotic intake include ...*

- *Decreasing pathogens and their toxins*
- *Altering bacterial community structure to enhance evenness*
- *Stabilizing bacterial communities when perturbed (eg. with antibiotics)*
- *Promoting a more rapid recovery from a perturbation.”*

WHICH PROBIOTICS?

The importance of variety

Different strains of probiotic bacteria have slightly different functions. They also colonise different places along the digestive tract. So probiotic supplements that contain multiple strains are more effective than products which contain very high concentrations of just one or two strains.

Moreover most strains work synergistically with each other to influence your health. So, beyond a certain number, more diversity of strains is probably more important than sheer numbers of probiotic bacteria.

In the West, we have considerably less microbial diversity than in other parts of the world and the likely cause is over use of antibiotics, antibacterial sprays and the prevalence of processed food which is largely produced in a sterile environment.

Significantly, most less-developed countries may have higher rates of infectious diseases, but they generally have much lower levels of allergies and asthma.

A wide ranging review of the subject in *Nature Reviews Genetics*, entitled '**The Human Microbiome: at the interface of health and disease**', confirmed the importance of bacterial diversity. It found that

"In H. pylori-negative individuals, gastric microbiota diversity is high."

In contrast, people with low microbial diversity had positive (high levels) of *H. pylori*.

H. pylori (*Helicobacter pylori*) is a very common but potentially dangerous bacterium that causes ulcers and gastric inflammation. Cancer Research UK also confirms that *H. pylori* is the cause of one in three stomach cancers. Other research suggests it may be a risk factor for heart disease.

The same *Nature Reviews Genetics* paper confirms that reduced microbial diversity and imbalances in the microbiome are strongly linked to Crohn's Disease, liver disease, rheumatoid arthritis and obesity.

The most important probiotic strains

The ***Lactobacillus*** species are the predominant bacteria that reside in the small intestine. These species are responsible for producing lactase, the enzyme required to break down lactose (the sugar in milk). So a probiotic containing lactobacillus is often recommended in cases of lactose intolerance.

They also collectively ferment carbohydrates in the gut, producing lactic acid as a result of this process. Lactic acid helps create an acidic environment in the digestive tract, which discourages many unwanted microorganisms that thrive in an alkaline environment. Lactic acid also increases absorption of minerals such as calcium, zinc, copper, magnesium and iron.

The important point to remember is that probiotic bacteria work synergistically with each other and several strains have duplicate functions. So you don't have to include all of the following. But you should have at least 5 - 7 shelf stable resistant strains in an effective probiotic supplement.

Lactobacillus

L. acidophilus
L. casei
L. plantarum
L. rhamnosus
L. paracasei
L. fermentum
L. bulgaricus

Bifidobacterium

B. lactis
B. bifidum
B. longum
B. infantis

Bacillus

B. coagulans

Streptococcus

S. thermophilus
S. salivarius

Variety achieves two things. It increases the number of strains in your intestines, which we know is correlated to health. We also know that some strains significantly benefit one person but not another. So having a wide variety gives you the best chance of the probiotic benefiting you.

By combining strains, a supplement has the best chance of improving immune function, enhancing digestion, controlling candida, inhibiting the growth of pathogens like *Helicobacter pylori* and even viruses, creating natural internal antibiotics, relieving IBD symptoms, improving mood and assisting in weight control – because different strains have different effects.

Appendix A (pp. 30-31) lists some of the most important strains of probiotic bacteria and what they do.

Will probiotics reach the gut?

Until recently, the medical view was that probiotic yoghurts and supplements were questionably effective, because the hostile environment of the stomach meant that most never reached the gut. And those that did mostly passed through to be excreted. That's why most supplements contain billions of bacteria on the assumption that some will get through.

Yet this mass casualty theory didn't square with the fact that many people taking probiotic supplements do report very real benefits and so many recent research papers concur.

A possible explanation of this apparent dichotomy was put forward in a panel discussion in May 2016 at *UCLA* called '**Microbes: From Your Food to Your Brain**'. The suggestion was made that the newly consumed probiotic bacteria could be exchanging genetic information with existing probiotic bacteria on their way through the GI (gastro-intestinal) tract and thus improving the balance.

This is quite plausible as we do know that such exchanges occur. Indeed genetic exchanges – via DNA strands called plasmids – are how pathogenic bacteria can develop antibiotic resistance.

Even so, it is hardly a ringing endorsement of probiotic supplementation.

The breakthrough – and the reason why occasional probiotic supplementation can and should be part of your health regime – lies in two developments: the effective delivery of **endospore probiotics** and of particularly hardy strains of **Lactobacillus** and **Bifidobacterium**.

THE 25-MILLION-YEAR-OLD BACTERIUM

When scientists discovered a 25-million-year-old bacterium in suspended animation within a fossilised bee, the obvious question was how could it have survived so long? The answer was that it was an endospore bacterium, which has a protective shell structure.



Scientists have now developed current probiotic bacteria with the same shell mechanism that preserved the bacillus endospore bacterium within that bee. These strains are able to survive the harsh acids of the bile duct and stomach and the anaerobic environment of your intestines. Once endospores reach the small intestines, the shell disintegrates, so the bacteria remain in the gut and can reproduce to form a colony.

The *Department of Microbiology at Cornell University* states:

“Endospores can survive environmental assaults that would normally kill the bacterium. These stresses include high temperature, high UV irradiation, desiccation, chemical damage and enzymatic destruction.

“The extraordinary resistance properties of endospores make them of particular importance because they are not readily killed by many antimicrobial treatments.”

Endospore ‘good’ bacteria

BACILLUS COAGULANS

The *University of Nebraska* started research on probiotic bacteria as early as 1925, so they have perhaps the most extensive database in the world.

The work at Nebraska has culminated in the development by Dr Shahani of a unique version of the probiotic strain **Bacillus coagulans** trademarked “ProDURA”. **Bacillus coagulans ProDURA** is an endospore bacterium that is stable at room temperature for up to three years’ storage. It is activated only with the specific conditions of heat, pH, and moisture found in the large intestine. Upon arrival, **Bacillus coagulans** cells begin multiplying and colonising the intestinal tract, which is the key to effectiveness.

In recent research, **Bacillus coagulans** showed promise for relieving symptoms of patients with IBS, for increasing immune response against adenovirus and influenza A, and even in reducing inflammation in arthritis sufferers.

Other resistant 'good' bacteria

RESISTANT LACTOBACILLUS ACIDOPHILUS

The same team at *Nebraska University* have also developed a strain of **L. acidophilus** called **DDS-1** which is shown to be activated by the mucosa of the intestines. Unlike other strains, it remains stable even at room temperature for as long as 24 months. In clinical studies it has been shown to enhance immune function and help suppress pathogenic bacteria such as *E. coli* and salmonella.

L. acidophilus DDS-1 and other strains developed at Nebraska are originally isolated from a human source. This is important, as strains isolated from animal sources – as in some yoghurts – do not implant or multiply in the intestinal tract well.

HOW TO TAKE PROBIOTICS

According to the research centre at the *University of Kentucky*, for a product to be called a **probiotic**, the micro-organisms must:

- **be live**
- **be present** in sufficient **numbers**
- bestow a **health benefit**

Note that the number of bacteria is measured in "colony-forming units" – abbreviated to CFUs.

So should you take probiotics in food or supplement form?

FOODS, PARTICULARLY YOGHURTS

The website *Medical News* makes the point that the term 'contains live and active cultures' often used on yoghurt labels refers to the organisms used in the fermentation process. But it's possible that yoghurts labelled this way may not contain **sufficient** amounts of **live** microorganisms to bestow a **health benefit** on the consumer. For example, pasteurised yoghurts have been flash heated at high temperatures so many microorganisms are destroyed.



Many other yoghurt labels will claim: "made with live bacteria" or "made with probiotics", rather than saying "contains" them.

That's because by the time the pot is transported to the store and stands in the chiller cabinet for a week or so, the bacteria may be dead or very few in number.

Assuming yoghurt-delivered probiotics do survive until you consume them, then they must now survive the harsh acidic environment of the stomach. The problem is that the milk culture gives little protection. Moreover, many yoghurts contain sugar which helps encourage the 'bad' bacteria.

So if a yoghurt doesn't state how many probiotic bacteria it contains – in billions – it may only have token amounts and therefore be of little benefit.

Even if the label states the number of probiotic units, it may say, for example, “5 billion per pot”. If the pot contains 500 grams of yoghurt, that’s only **10 million per gram**. It still sounds a lot but, for example, the ProDURA variant of endospore bacteria **Bacillus coagulans** contains as much as **20 billion per gram**, ie. 200 times more!

Numbers matter, because however hardy the strain, many will not survive to colonise the gut – which is the intended end result. A *University College London* study in 2014 tested some top brand yoghurts and found that very few of their friendly bacteria survived in the stomach.

Indeed a December 2016 article written by an eminent gastroenterologist on *Medscape* states:

“... expected clinical end points may not be achieved by generically recommending yoghurt to patients in whom a purported probiotic benefit is desired ... (although) yoghurt consumption has other benefits including improved lactose tolerance and the provision of protein, vitamin D, and calcium.”

But if yoghurts are not the best way to help achieve probiotic balance, why do they have such a good image?

Yoghurts – the difference is in the modern processing

In the early 1900s, a researcher called Dr Metchnikoff was intrigued that so many Bulgarian villagers were living to 100 or more. He attributed their longevity to the consumption of large quantities of raw yoghurt fermented by lactic acid producing bacteria which inhibited pathogens.

We’ve seen there is indeed a direct correlation between health and probiotic balance and range, so Dr Metchnikoff was right. But the conclusion he reached with **raw** cultures is not applicable to modern mass-produced, largely high-temperature-pasteurised, yoghurts. Not only does pasteurisation kill bacterial strains but many other nutrients are heat sensitive and reduced in level by pasteurisation – including vitamin C, B vitamins and vitamin E.

Mainstream yoghurt tastes good and is a pleasant, safe addition to your diet, but not the best choice for a true probiotic boost. And do try to choose ‘live’ ones with no added sugar, ideally made from organic cow’s milk, sheep’s or goat’s milk (because the animals will have been grass-fed) or plant-based (eg. soy).

All this suggests that the delivery mechanism of probiotics in supplement form should be superior to a yoghurt for real health benefits.

PROBIOTIC SUPPLEMENTS

You should choose a supplement brand that provides evidence of a proper scientific approach.

The University of Nebraska has tested over 200 probiotic products over the years. They found that 70% had CFU (colony-forming unit) counts lower than on the label and a significant proportion had as little as 10% of the claimed count!

Powder, tablet or capsule form?

POWDERS

The disadvantage of **powders** is that they are exposed during transit and storage to variations in heat and humidity which can reduce the viability of the bacteria. And when consumed, they are immediately exposed to stomach acid.

TABLETS OR CAPLETS

Tablets are a poor choice as they are subjected to very high heat in the process of manufacture, which will kill most of the bacteria.

HARD-SHELL CAPSULES

By far the best delivery system is vegetable **hard-shell capsules**. They resist breakdown in the stomach for a time – enough for a majority of the probiotic bacteria to reach the gut, as long as they are resistant strains.

The combination of endospore and other resistant strains of probiotics coupled with hard shell capsules containing billions of live bacteria per capsule is the gold standard in probiotic supplementation.

Will the probiotic bacteria colonise?

A review article in the *American Journal of Clinical Nutrition* posed this very question. It started by acknowledging that some researchers were sceptical about the effectiveness of probiotics. Having examined hundreds of studies, however, it concluded that some ingested probiotics can indeed affect the composition and behaviour of intestinal microflora and:

“Probiotics, perhaps in combination with prebiotics, may become an important means of preventing and treating disease. For example, several types of diarrhea have been successfully treated with probiotics.

“This practice, however, may represent only the “tip of the iceberg” because the potential benefits of probiotic therapy promise to be almost limitless.”

Probiotic bacteria are living things. So they need food if they are to thrive and if new colonies are to take hold. This nourishment is the role of prebiotics.

INCLUDE PREBIOTICS

Prebiotics are non-digestible plant fibres which promote the growth of probiotics in the intestines. Prebiotic fibre is found in many fruits and vegetables, such as apples, bananas, onions, leeks and garlic, Jerusalem artichoke, asparagus, chicory root and legumes like lentils, chickpeas, and beans. It is also found in wholegrains.

See [Appendix C](#) (p 33) for the top prebiotic foods.



Well-designed microbiome booster supplements ideally also include prebiotics such as inulin and fructo-oligosaccharides (FOS) as a 'kick starter' to the process of colonisation when the probiotic bacteria 'wake up' in the gut.

A supplement – as the name implies – is additional to the basis of a good diet; in this case a diet rich in probiotics and prebiotics.

So although there is good evidence to take periodic probiotic supplements to boost the level and variety of good bacteria in your gut, you do need to incorporate prebiotic and probiotic foods into your daily and weekly diet. That's what [Appendices B and C](#) (pp. 32-33) help you do.

RECOMMENDED PROBIOTIC SUPPLEMENTATION

The best time to take a probiotic supplement is with food. This not only helps buffer the probiotics from acidity but provides food to help colonisation.

FOR ADULTS

To generally rebalance your microbiome

Look for a probiotic supplement containing between 5 and 7 resistant strains – at least one of which should be an endospore strain such as ***Bacillus coagulans***. They should be contained in a hard shell capsule and include some prebiotic fibre.

A Colony Forming Unit (CFU) count of a total of **7 billion** per day for 60 days should be enough to start rebalancing your microbiome. This number seems a lot, but there is always loss during the journey through the intestinal tract and the residual numbers of each strain needed to build a colony are high.

Follow the 8-week regime three times a year, to increase both the numbers and the range of beneficial probiotics in your gut.

This 3 times a year 'regime' can be especially beneficial for older people (over 60 - 65) because some studies indicate that digestive efficiency declines with age.

To control digestive problems

According to NHS England, quoting Dr Anton Emmanuel, consultant gastroenterologist at University College Hospital London, approximately 40% of people have at least one symptom of digestive problems at any one time.

A well designed probiotic supplement can be a healthier, safer and natural alternative to over-the-counter remedies for constipation, diarrhoea and bloating – without side-effects.

Use the 3 times a year regime to combat and help prevent digestive problems in the long term.

After antibiotics

If you have just completed a course of antibiotics (remember – always complete the FULL course), take a total of **14 billion** CFUs a day for two weeks, Then take **7 billion** a day for 4 weeks.

To prevent Traveller's Diarrhoea

Take **7 billion** a day for 14 days before travel, the same during travel and continue with 7 billion a day for 14 days after returning.

In the case of a candida yeast infection or thrush

Take **14 billion** CFUs a day for 4 weeks as soon as you notice symptoms and in combination with any medicines prescribed by your doctor or pharmacist.

As part of a weight-reducing diet

If you are using a probiotic supplement to accompany a weight loss diet the evidence strongly suggests at least 8 weeks of supplementation at **7 billion** CFUs a day.

In times of stress

Take **7 billion** a day for a 30 – 45 day period. Students should consider taking a probiotic at this level in the 8 weeks prior to taking exams and during the exam period.

FOR CHILDREN

For children over the age of 10, a 7 billion capsule every 5 days should be enough to maintain a healthy balance of probiotics. After a course of antibiotics make this 7 billion a day for 7 days.

Safety considerations

Probiotics very rarely cause serious side effects. However, if you take too much too quickly, you may experience a temporary bout of gas or diarrhoea. If so, reduce the dose for a time to allow your system to adjust. If you are under medical supervision for a serious condition, check with your doctor.

INCREASE PRO- AND PRE-BIOTIC FOODS IN YOUR DIET



Although there is a strong case for boosting the number and variety of your intestinal probiotics with an occasional 60-day booster, it is through food that you should mainly maintain a healthy microbiome.

The foods in [Appendix B](#) (p 32) are rich in probiotics and often with a good prebiotic content too.

The prebiotics feed the probiotics. There is no point in boosting probiotics without providing the food they need every day to thrive and multiply. [Appendix C](#) (p 33) lists the top prebiotic foods.

One prebiotic fibre that has a very positive side-effect is porridge oats. It not only feeds probiotic bacteria; it also includes oat beta glucans which have been shown to reduce cholesterol.

MY RECOMMENDATIONS

I believe most people would benefit from taking a well-designed probiotic supplement on a regular basis. Because ...

- Probiotics 'crowd out' harmful bacteria, restore a healthy balance in the gut, synthesise some vital vitamins like K2, folic acid and B12, and are crucial to strong immune function. So increasing your intake of fermented foods and taking a probiotic supplement on occasions will contribute to better health.
- Probiotics need prebiotics to develop beneficial colonies.
- A well-designed probiotic supplement can be recommended to help restore intestinal health after a course of antibiotics, to improve nutrient absorption in older people, to fight candida, and to prevent traveller's diarrhoea.
- Many people find that a probiotic supplement can improve digestion, boost the results of a weight loss regime, improve blood sugar levels and help reduce cholesterol levels.
- A probiotic supplement can support treatment for IBS – Irritable Bowel Syndrome.
- Because there is a clear gut to brain loop, probiotics may also help reduce stress and improve mood.
- A probiotic supplement needs to include several strains, as research clearly shows that a microbiome with a broader range of 'friendly bacteria' is linked to better health. In addition, each person's microbiome is different and more strains give a better chance for the full benefit of improved intestinal balance.
- A probiotic supplement should include strains with evidence that they can survive the acid of the stomach and reach the parts of the gut where they can colonise.
- A probiotic supplement should also include some prebiotics to 'kick-start' the process of colonisation.
- A probiotic supplement should be at a minimum of 7 billion a day.
- Yoghurts are a good and healthy food, but most have limited effectiveness as a probiotic supplement, because heat treatment destroys most of the bacteria – friendly or otherwise.

Colin Rose

May 2017

APPENDIX A: TOP PROBIOTIC BACTERIA

LACTOBACILLUS		FROM: LACTIS = MILK BACILLUS = ROD
<p><i>Lactobacillus</i> bacteria are the most numerous and important of the species in the small intestine. They:</p> <ul style="list-style-type: none"> • produce the enzyme lactase, which breaks down the milk sugar lactose • ferment carbohydrates in the gut, producing lactic acid which helps create an acidic environment • inhibit "bad" bacteria that prefer alkaline surroundings • help mineral absorption 		
L. ACIDOPHILUS		
<p>There are many sub-strains of <i>L. acidophilus</i>, some of which are more suited to taking in supplements and foods, as they better survive the stomach acids and bile salts of the digestive system. Variant DDS-1 is one of these, which has been shown to survive, multiply and form a colony in the intestinal wall.</p>		
<ul style="list-style-type: none"> • Supports nutrient absorption and helps creates vitamin K • Relieves gas and bloating and helps with the digestion of dairy foods 	<ul style="list-style-type: none"> • Helps to kill pathogenic bacteria like candida and <i>H. pylori</i> and has been shown to reduce harmful <i>E. coli</i> • Supports vaginal health 	
L. BULGARICUS		
<p><i>L. bulgaricus</i> is a "starter culture" in the dairy industry that encourages the growth of other probiotic bacteria. Some strains have been shown to withstand the low pH levels within the stomach during digestion. Colonies appear to grow when they are needed and decrease in level when they are not.</p>		
<ul style="list-style-type: none"> • Helps neutralise toxins 	<ul style="list-style-type: none"> • Kills harmful bacteria by producing its own natural antibiotics 	
L. CASEI		
<ul style="list-style-type: none"> • Supports immunity • Inhibits the growth of <i>H. pylori</i> and helps fight infections 	<ul style="list-style-type: none"> • Combined with other probiotic strains prevented antibiotic-associated diarrhoea (AAD) and <i>Clostridium difficile</i> infections 	
L. FERMENTUM		
<p>This strain, which has been found in the probiotic foods sourdough and kimchi, produces superoxide dismutase and glutathione, both powerful antioxidants.</p>		
<ul style="list-style-type: none"> • Acts against foodborne pathogens 	<ul style="list-style-type: none"> • Helps neutralise toxic products made during digestion 	
L. PARACASEI		
<p>A robust strain found in the small intestine. May also colonise the colon if taken with milk protein, increasing its resistance to stomach acid.</p>		
<ul style="list-style-type: none"> • Unique liver function support. A study including it lowered urine pH and improved liver function in half of subjects. 	<ul style="list-style-type: none"> • Acts against foodborne pathogens 	
L. PLANTARUM		
<ul style="list-style-type: none"> • Effective in supporting immune function • May reduce the incidence of <i>Clostridium difficile</i> associated disease in hospital patients following antibiotic administration 	<ul style="list-style-type: none"> • Possible decreased risk of colorectal cancer • Synthesises the amino-acid L-lysine 	
L. RHAMNOSUS		
<p>Recognised for its ability to survive passage through the acidic GI tract.</p>		
<ul style="list-style-type: none"> • Supports bacterial balance, vaginal health and healthy skin • Helps fight urinary tract and respiratory infections • May reduce anxiety by reducing the level of stress hormones 	<ul style="list-style-type: none"> • Can help prevent traveller's diarrhoea • Potential treatment for gastrointestinal issues like IBS (irritable bowel syndrome) 	

BIFIDOBACTERIUM	FROM: BIFID = TWO BRANCHES
<p><i>Bifidobacteria</i> are particularly active as a scavenger of toxins, helping remove lead and heavy metals. They mainly inhabit the large intestine (colon). Numbers of <i>bifidobacteria</i> decline with age. They:</p> <ul style="list-style-type: none"> • Support liver function • Help reduce inflammation 	
B. BIFIDUM	
<p>The most dominant probiotic in the large intestine. Important for its ability to break down complex carbohydrates, fat, and protein into small components that the body can use more efficiently.</p> <ul style="list-style-type: none"> • Supports the production of vitamins • Inhibits harmful bacteria • Helps prevent diarrhoea 	
B. INFANTIS	
<p>Comprises the largest population of beneficial bacteria in babies. Declines with age, but remains an important part of our microflora. Supplementation has been shown to decrease bloating and bowel movement difficulty.</p>	
B. LACTIS	
<ul style="list-style-type: none"> • May support healthy cholesterol levels • Eases ulcerative colitis • Mitigates the effects of coeliac disease 	
B. LONGUM	
<p>Elderly patients administered <i>B. longum</i> showed heightened immune function for 20 weeks after discontinuing supplementation, which indicates that it can establish a colony.</p>	

BACILLUS	FROM: BACILLUS = ROD
<p><i>Bacillus</i> are rod-shaped, 'endospore' (spore-bearing) bacteria that produce lactic acid. Endospore bacteria are highly resistant to heat, moisture, light and stomach acid. They readily form colonies in the small intestine. <i>Bacillus</i> also stays in the body longer than many other bacteria.</p>	
B. COAGULANS	
<ul style="list-style-type: none"> • Aids nutrient absorption • Improves the body's ability to use calcium, phosphorus, iron • Stimulates gastric motility and digestion • Reduces inflammation and the symptoms of arthritis 	

STREPTOCOCCUS	FROM: STREPTO = TWISTED COCCUS = BERRY
S. THERMOPHILUS also known as S. SALIVARIUS THERMOPHILUS	
<p>An important and hardy strain that may support colon health possibly even lowering the risk for colon cancer.</p> <ul style="list-style-type: none"> • Protects against small intestine irritation • Fights against antibiotic-associated diarrhoea (AAD) • May be helpful during chemotherapy by protecting the intestinal tissues from irritation caused by chemo drugs 	
S. SALIVARIUS	
<p>Found in the mucous membranes of the mouth and throat, they produce bacteriocin-like inhibitory substances (BLIS), which inhibit the growth of undesirable bacteria. The 10% of people who naturally carry BLIS-producing oral bacteria have significantly fewer sore throats.</p> <p>S. salivarius K12 and M18 both produce BLIS. K12 is linked with better ear health in children, reduced dental plaque, increased levels of immune marker interferon gamma in saliva and reduction in sulphur compounds that cause bad breath.</p> <p>M18 is most active in specific areas on the gums and teeth and promotes a healthy inflammatory response in the gums.</p>	

APPENDIX B: TOP **PROBIOTIC** FOODS

Fermented cabbage



Sauerkraut and kimchi are both fermented cabbage products offering the healthy kind of bacteria or probiotics. **Sauerkraut** is high in vitamin C and digestive enzymes. It is also a good source of natural lactic acid bacteria such as *Lactobacillus*.

Kimchi is the Korean version of sauerkraut. It mixes Chinese cabbage with spices like red pepper flakes, radishes, carrots, garlic, ginger, onion, sea salt and fish sauce. The mixture is then left aside to ferment for 3-14 days.

Unpasteurised cheese

Cheeses are created by fermentation. The process involves adding microbes to the starter product (a culture of lactic acid bacteria) and allowing it to ferment. If you buy pasteurised cheese, you will not be getting any of the probiotic benefits. Pregnant women, of course, need to avoid unpasteurised cheese.

Kefir

Kefir or kephir (also known as milk kefir, or búlgaros) is a fermented milk drink made with kefir "grains" – a yeast/bacterial fermentation starter. It is usually prepared by inoculating cow's, goat's or sheep's milk with kefir grains, but coconut kefir can also be made from coconut water or coconut milk.

The term kefir comes from the Turkish word *keif* meaning 'good feeling' and kefir has been consumed for over 3,000 years in Russia and Turkey. The yeasts in kefir break down lactose in the milk which is why kefir is suitable for those who are lactose intolerant.



Miso

Miso is a traditional Japanese food created by fermenting soybean, barley, or brown rice with the fungus 'koji'. The fermentation process takes anywhere from a few days to a few years to complete. The result is a red or dark brown paste with a buttery texture.

Miso can be made into a soup, added to stews or the paste can even be spread on crackers.

Natto



Natto is another traditional Japanese (mostly breakfast) food and is another version of fermented soybean. Natto contains the probiotic *Bacillus subtilis*, which has been proven to boost your immune system. It is also a very good source of vitamin K2, which is important for heart health.

Natto also contains vitamin B12, which is often lacking in vegan diets and is a good source of plant protein at 18 grams per 100 grams. Well worth eating – but it is rather an acquired taste!

Tempeh

Another fermented soybean product, this time from Indonesia. It is in a cake form, and because it has a high protein content is often used as a meat substitute in a stir-fry. It has a nutty flavour and is often accompanied by miso or soy sauce.



Yoghurt

Yoghurt would be expected to be at the top of a probiotic list – because the market is huge. The problem is the huge variation in quality. Read the labels carefully! Check particularly for live named cultures and no added sugar.

APPENDIX C: TOP **PREBIOTIC** FOODS

Garlic, Onions and Leeks

Garlic and **onions** contain about 10% inulin and 6% FOS. **Leeks**, from the same family as garlic and onions, contain up to 16% inulin.

Apples and Bananas



Interestingly, these two very popular fruits are both high in prebiotic fibre. **Apples** contain pectin, which increases butyrate, a short-chain fatty acid that feeds the beneficial gut bacteria and decreases the population of harmful bacteria. **Bananas** are rich in vitamins, minerals and fibre, small amounts of which are the prebiotic inulin. Unripe (green) bananas are also high in resistant starch, which has prebiotic effects.



Jerusalem artichokes

The Jerusalem artichoke is also known as the “earth apple”. It provides about 2 grams of dietary fibre per 100 grams, 76% of which comes from inulin.

Asparagus

You probably don't realise how much great prebiotic fibre is in this delicious vegetable. There can be as much as 2 to 3 grams of inulin in a 100g serving!

Cruciferous vegetables

Cabbage, broccoli, Brussels sprouts and similar greens contain the prebiotic galacto-oligosaccharides (GOS).

Wholegrains



Barley contains 3–8 grams of prebiotic beta-glucan fibre per 100 grams.

Oats contain large amounts of beta-glucan fibre, too, as well as resistant starch.

Wheat bran is the outer layer of the whole wheat grain. It is an excellent source of prebiotics, with a special type of fibre called arabinoxylan oligosaccharides (AXOS). AXOS fibre represents about 65% of wheat bran's fibre content.

Flax seeds

Flaxseeds are a great source of prebiotics. They contain 20–40% soluble fibre from mucilage gums and 60–80% insoluble fibre from cellulose and lignin.

The fibre in flaxseeds promotes healthy gut bacteria, promotes regular bowel movements and reduces the amount of dietary fat you digest and absorb.

Seaweed

Seaweed (marine algae) is rarely eaten, except, of course, in Japan – and in Wales as 'laverbread'. However, it is a very potent prebiotic food.



Roots – Chicory, Burdock, Konjac, Jicama, Yacon

High in prebiotic fibre such as inulin, FOS and glucomannan.

Cocoa

Flavanol-containing cocoa has powerful prebiotic benefits associated with the growth of healthy gut bacteria. It also has benefits for the heart. Be careful about adding too much sugar, though!

REFERENCES

- Sanders ME. Impact of probiotics on colonizing microbiota of the gut. *J Clin Gastroenterol*. 2011 Nov;45 Suppl:S115-9.
- Cano RJ & Borucki M. Revival and identification of bacterial spores in 25 to 40 million year old Dominican amber. *Science* 268, 1060 - 1064 1995.
- Petschow B et al. Probiotics, prebiotics, and the host microbiome: the science of translation. *Ann N Y Acad Sci*. 2013 Dec;1306:1-17.
- Jackie D Wood et al. Anti-Enteric Neuronal Antibodies and the Irritable Bowel Syndrome. 2012 Jan; 18(1): 78–85. *Gut*. 2004 Oct;53(10):1459-64.
- Al-Salami H, Butt G, Fawcett JP, Tucker IG, Golocorbin-Kon S, Mikov M. Probiotic treatment reduces blood glucose levels and increases systemic absorption of gliclazide in diabetic rats.
- Gut Microbiota Regulate Motor Deficits and Neuroinflammation in a Model of Parkinson's Disease: Mazmanian, Sarkis K. et al (2016) Gut Microbiota Regulate Motor Deficits and Neuroinflammation in a Model of Parkinson's Disease. *Cell*
- Vrese M, Marteau P. Probiotics and Prebiotics: Effects on Diarrhea. *J. Nutr.* March 2007 vol. 137 no. 3 803S-811S.
- Lomax AR, Calder PC. Probiotics, immune function, infection and inflammation: a review of the evidence from studies conducted in humans. *Curr Pharm Des*. 2009;15(13):1428-518.
- Lindfors K, Blomqvist T, Juuti-Uusitalo K, et al. Live probiotic *Bifidobacterium lactis* bacteria inhibit the toxic effects induced by wheat gliadin in epithelial cell culture. *Clin Exp Immunol*. 2008 Jun; 152(3): 552-558.
- Jungersen M, Wind A, Johansen E, et al. The Science behind the Probiotic Strain *Bifidobacterium animalis* subsp. *lactis* BB-12. *Microorganisms* 2014, 2, 92-110.
- Probiotics.org*. B. Lactics Probiotics Supplementation Benefits. *Microbiol Mol Biol Rev*. 2000 Sep; 64(3): 548–572.
- Nicholson WL, Munakata N, Horneck G, Melosh HJ, Setlow P. Resistance of *Bacillus* Endospores to Extreme Terrestrial and Extraterrestrial Environments. *Appl Environ Microbiol*. 2006 Jul; 72(7): 5113–5117.
- Elli M, Callegari ML, Ferrari S, Bessi E, Cattivelli D, Soldi S, Morelli L, Feuillerat NG and Antoine J-M. Survival of Yogurt Bacteria in the Human Gut
- Schmidt, K. et al. Prebiotic intake reduces the waking cortisol response and alters emotional bias in healthy volunteers. *Psychopharmacology*, 232 (10).
- Beerepoot MA et al. Lactobacilli vs antibiotics to prevent urinary tract infections: a randomized, double-blind, noninferiority trial in postmenopausal women. *Archives of Internal Medicine*. 172 (9).
- Lee JY et al. Effects of 12 weeks of probiotic supplementation on quality of life in colorectal cancer survivors: A double-blind, randomized, placebo-controlled trial. *Digestive and Liver Disease*, 46(12), 1126-1132
- Sullivan A, Nord CE & Evengard B. Effect of supplement with lactic-acid producing bacteria on fatigue and physical activity in patients with chronic fatigue syndrome. (2009). *Nutr J*, 8(4).
- Fedorak RN, Madsen KL. Probiotics and the management of inflammatory bowel disease. *Inflamm Bowel Dis*. 2004 May;10(3):286-99
- Chenoll E, Casinos B, Bataller E. Novel Probiotic *Bifidobacterium bifidum* CECT 7366 Strain Active against the Pathogenic Bacterium *Helicobacter pylori*. (2011) *Applied Environmental Microbiology* 77(4) 1335-1343.
- Reddy BS, Rivenson A. Inhibitory effect of *Bifidobacterium longum* on colon, mammary, and liver carcinogenesis induced by 2-amino-3-methylimidazo[4,5-f]quinolone a food mutagen. (1993) *Cancer Research*, 53(17) 3914-8.
- Whorwell PJ et al. Efficacy of an Encapsulated Probiotic *Bifidobacterium Infantis* in Women with Irritable Bowel Syndrome. *American Journal of Gastroenterology*, 101(7) 1581-90.
- McFarland LV. Evidence-based review of probiotics for antibiotic-associated diarrhea and *Clostridium difficile* infections. (2009) *Clinical Microbiology*, 15(6), pp. 274-278.
- Bravo J et al. Ingestion of *Lactobacillus* strain regulates emotional behavior and central GABA receptor expression in a mouse via the vagus nerve. (2011) *Proc Natl Acad Sci*, 108(38), pp. 16050–16055.
- Mandel D, Eichas K, Holmes J. *Bacillus coagulans*: a viable adjunct therapy for relieving symptoms of rheumatoid arthritis according to a randomized, controlled trial. (2010) *BMC Complementary and Alternative Medicine*, 10(1186), pp. 1472-6882.
- Sanchez M et al. Effect of *Lactobacillus rhamnosus* CGMCC1.3724 supplementation on weight loss and maintenance in obese men and women. *British Journal of Nutrition*, 2013; 1 DOI: 10.1017/S0007114513003875

Zhang Q, Wu Y, Fei X. Effect of probiotics on body weight and body-mass index: a systematic review and meta-analysis of randomized, controlled trials. *International Journal of Food Sciences and Nutrition*, 2016; 67 (5): 571 DOI: 10.1080/09637486.2016.1181156

Liong M-T. Roles of Probiotics and Prebiotics in Colon Cancer Prevention: Postulated Mechanisms and In-vivo Evidence *Int J Mol Sci*. 2008 May; 9(5): 854–863.

Urgesi R, Casale C, Pistelli R, Rapaccini GL, de Vitis I. A randomized double-blind placebo-controlled clinical trial on efficacy and safety of association of simethicone and *Bacillus coagulans* (Colinox®) in patients with irritable bowel syndrome. *Eur Rev Med Pharmacol Sci*. 2014;18(9):1344-53.

Akkasheh G. Clinical and metabolic response to probiotic administration in patients with major depressive disorder: A randomized, double-blind, placebo-controlled trial, et al; *Nutrition Journal* 2015

LINKS

<https://www.scientificamerican.com/article/gut-second-brain/>

https://www.theguardian.com/society/2014/jun/01/why-antibiotics-making-us-ill-bacteria-martin-blaser?CMP=tw_t_f_d

<https://micro.cornell.edu/research/epulopiscium/bacterial-endospores>

http://www.cdc.gov/ncidod/dbmd/diseaseinfo/travelersdiarrhea_g.htm

<http://www.ca.uky.edu/agc/pubs/fcs3/fcs3555/fcs3555.pdf>

http://www.pbrc.edu/training-and-education/pdf/pns/PNS_Probiotics.pdf

http://www.medscape.com/viewarticle/770468_7

<https://www.asm.org/index.php/journal-press-releases/94202-probiotics-mitigate-stress-in-medical-students-at-exam-time>